Jet Propulsion Laboratory **AIRS Design File Memorandum #648**
June 24, 2003

To: Tom Pagano

From: Thomas Hearty

CC: H. Aumann, S. Broberg, D. Elliott, S. Friedman, S. Gaiser, T. Hearty, B. Lambrigtsen, S. Lee, S. Licata, E.Manning, E. Olsen, K. Overoye, D. Ting, M. Weiler

Subject: Changes to the AIRS Level 1B Algorithms and Quality Assessment Parameters

Summary: This memo describes changes to the Level 1B QA Requirements that were implemented by the release of version 2.7.x of the PGE. It also addresses an action item assigned to Thomas Hearty to resolve the differences between the old and the new NeN algorithms.

1 Introduction

This document provides a brief description of the AIRS Level 1B algorithms that have been altered as a result of experience with in-flight AIRS data. The latest version of the L1B requirements document should be consulted for a precise explanation of these algorithms. The affected algorithms and L1B Quality Assessment parameters are listed in Table 1.

Table 1: Changed Parameters

Algorithm	PGE Version	Affected L1B parameters
AutomaticQAFlag	2.6.5.5	**AutomaticQAFlag**
DC Restore	2.2.3.0	**DCR_scan**
offset	2.6.5.5	**radiances**
Pop Detection	2.6.8.2, 2.6.10.3, 2.6.16.3	**SpaceViewDelta**
		radiances
Noise Estimation	2.6.16.3	**NeN**
		input_space_signals
		input_bb_signals
Moon-in-View	2.7.10.3	**CalFlag**
		CalScanSummary
gain	2.7.10.3	**input_bb_signals**
		CalFlag

2 AutomaticQAFlag

The **AutomaticQAFlag** has been altered so that it no longer depends on the **CalGranSummary**. As before, it is a string which will always be "passed," "failed," or "suspect." However, it is now solely based on the **state** of the Earth scene footprints.

AutomaticQAFlag =
"passed" if **NumProcessData** $\neq 0$ and **NumSpecialData** + **NumBadData** $= 0$;
"failed" if **NumProcessData** $= 0$; "suspect" all other cases.

The **NumXXXData** parameters are based on the **state** flag as described in Table 2.

Table 2: **NumXXXData** Parameters

Name	Definition
NumTotalData	Number of Earth scene footprints expected in the granule
NumProcessData	Number of Earth scene footprints with state = 0
NumSpecialData	Number of Earth scene footprints with state = 1
NumBadData	Number of Earth scene footprints with state = 2
NumMissingData	Number of Earth scene footprints with state = 3

3 DC Restore and Space View Offset

The new DC Restore and space view offset algorithms have already been described in ADFM #573. Briefly, these new algorithms correctly account for a delay between when the DC Restore actually occurs and when it is reported in the Level 1A telemetry. Also, the effect of DC Restores has been accounted for in the calculation of the space view offset and DC Restores are no longer mistakenly flagged as pops.

4 Pop Detection

After launch the calibration team realized that the pop detection algorithm used by the PGE flagged numerous events that are not actual pops. These "events" have come to be known as "cold scene noise." These are intermittent periods in which detectors appear to be very noisy while viewing space but are less noisy while viewing a warm source. Examining a long time series of data shows that only a small number of channels with ABstate < 3 exhibit this type of behavior. Nevertheless, a new algorithm was developed which defines a pop as a discontinuity in the detector offset that is sustained for ≥ 2 sets of calibration footprints (i.e., > 1 scan line).

Although the new "pop" detection algorithm was altered so that it would only flag events that exhibit classic pop behavior (i.e., a sharp discontinuity in the detector offset), some "cold scene noise" events still cause the "pop" bit to be set in the scan before a DC Restore because of the lack of a suitable warm target to use in the algorithm. However the occurrences of "cold scene noise" being flagged as pops has been severely curtailed.

Also, the threshold for flagging pops has been increased so that the offset must change by $7 \times$ the standard deviation of **SpaceViewDelta** to be flagged as a pop. Since this threshold is very large, it leaves many significant pops undetected. Thus the threshold may be reduced in the future.

5 NeN algorithm

A new **NeN** algorithm has been implemented which includes the noise of the detectors when viewing space and the noise when viewing the On Board Calibration source. The previous algorithm calculated the **NeN** from the signal to noise ratio of the gain multiplied by a factor "snr_fac" determined from preflight data. Specifically, the old algorithm calculated the **NeN** as follows:

$$\mathbf{NeN} = \mathrm{N}_{250}/(\mathrm{snr} \times \mathrm{snr\_fac})$$

where,
N_{250} = The Planck Function evaluated at 250 K
snr = |gain_stats.mean| / gain_stats.dev
snr_fac = is determined from preflight data.

The new algorithm required the creation of 2 new L1B QA limited engineering structures: **input_space_signals** and **input_bb_signals**. The new limited engineering structures are similar to **input_space_counts** and **input_bb_counts** but they provide statistics on the signals rather than the counts.

The new algorithm computes **NeN** once per granule for each channel for an assumed scene temperature of 250 K using the following equation:

$$\mathbf{NeN} = \mathrm{gain} \times \sqrt{\mathrm{N}_{250}/\mathrm{N}_{\mathrm{T_{bb}}}(\mathrm{Noise}^2_{\mathrm{bb}} - \mathrm{Noise}^2_{\mathrm{sv}}) + \mathrm{Noise}^2_{\mathrm{sv}}}$$

where,
gain = |**gain_stats.mean**|
T_{bb} = **input_bb_temp.mean**
$\mathrm{Noise}_{\mathrm{sv}}$ = mean(**input_space_signals.dev**)
$\mathrm{Noise}_{\mathrm{bb}}$ = **input_bb_signals.dev**
N_{250} / $\mathrm{N}_{T_{bb}}$ = Ratio of the Planck Function evaluated at 250 K and at the temperature of the "On-Board Calibrator."

Figure 1 displays the NEdTs using both methods for Granule 50 on September 6, 2002 and the differences between the NEdTs. The differences between the 2 algorithms are small. Although the new algorithm does not depend on obfuscated preflight data, both algorithms assume the scene temperature is 250 K.

When the **NeN** for a given channel exceeds the noise limits, the "noise out of bounds" bit is set in the **CalChanSummary** (and **CalGranSummary** if any channel with ABstate < 3 exceeds the threshold). Currently, the "noise out of bounds" bit is set if the **NeN** is different by more than 50% of the expected value. The expected value is the median **NeN** taken over a long period (> 100 granules) after "noise out of bounds" conditions have been removed.

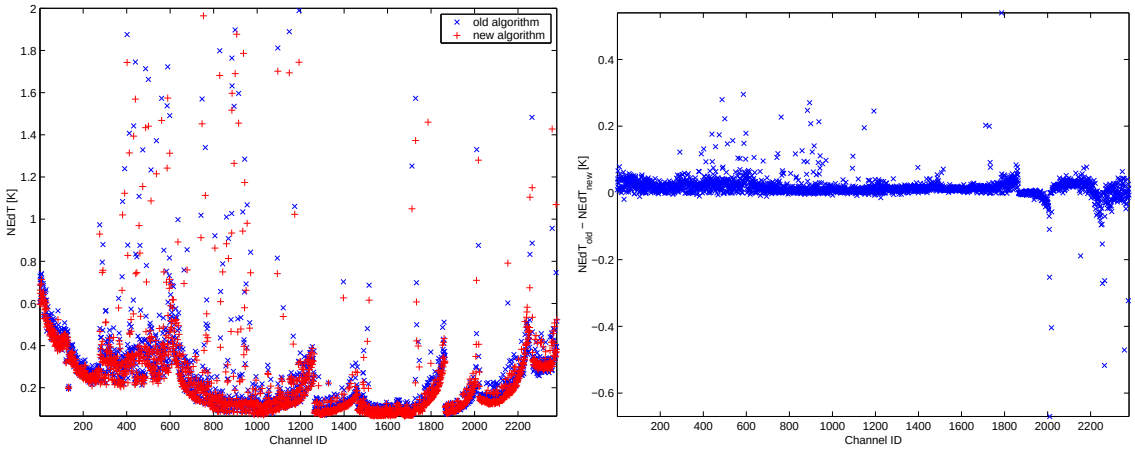

Figure 1: The left panel displays the NEdTs using both the old and the new algorithms for Granule 50 on September 6, 2002. The right panel displays the difference between the 2 algorithms. The NeN was converted to NEdT by dividing by the derivative of the Planck function with respect to temperature evaluated at 250K.

6 Moon-in-View algorithm

The Moon can sometimes be seen in the AIRS space view port (ADFM #643). Since the Moon has a noticeable effect on the offset calculation, the space views in which the Moon is present are not used to calculate the offset, the **NeN**, and they are omitted from the statistics when calculating the limited engineering structure **input_space_signals**. A bit is also set in the **CalFlag** and **CalScanSummary** to flag the scans in which the Moon was seen by one of the 8 space views normally used in the offset calculation.

7 gain bit

Since some "dead channels" (i.e., unresponsive) were causing the "noise out of bounds" bit the be set in the calibration flags, the gain is now set to -9999 and the "gain" bit is set in the **CalFlag** and **Cal*Summary** words when the signal (i.e., counts - offset) is $< 2\%$ of the dynamic range when viewing the On Board Calibration Source. This causes dead channels to be flagged as having a bad gain rather than being flagged as noisy.

8 Possible Changes to be made

There are several remaining changes that may be made to the Level 1B QA parameters and algorithms in the future.

1. The Pop detection threshold may be reduced. Version 2.7.x of the PGE still has large pops that are not flagged because they are below the current pop detection threshold.

2. Some channels with ABstate < 3 occasionally exhibit "cold scene noise." They are currently flagged by the "noise out of bounds" bit in the **CalChanSummary** and **CalGranSummary**. The calibration team will account for these channels either by adjusting their ABstate so that they no longer exhibit "cold scene noise," make their ABstate > 2, or altering the definition of **ExcludedChans** so they will no longer be reported in the **CalGranSummary**.

3. The "moon-in-view" bit in the **CalFlag** and **CalChanSummary** of PGE version 2.7.x may occasionally flag scan lines that have DC Restores as having the moon in view. This has already been fixed in PGE version 2.8.x.

4. The **NeN** algorithm may be modified to include the scene temperature rather than assuming a 250 K scene.